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China's Cement Industry

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China's Cement Industry

*Central Intelligence Agency
National Foreign Assessment Center
November 1977*

Summary

China is the world's fourth largest producer of cement with an estimated output of 49 million metric tons in 1976. More than half this total, however, is low-quality cement suitable only for rural and low-strength construction projects. Like many of China's industries, the cement industry consists of both modern (large) and small plants.

Contribution of Small Plants

Small plants have outproduced modern plants since 1973 by a wide margin. In 1976, small plants produced nearly 30 million tons, or 60 percent of national output. China now has 3,000 small plants, a tenfold increase since 1965. Some "small plants" are of fairly substantial size, and perhaps 500 of the largest produce up to three-fourths of total output. Most cement from small plants is used locally to support rural construction and a widespread water conservation program, thereby saving transportation and distribution costs.

Lagging Modern Sector

Modern plant production has fallen well behind small-plant output despite considerable expansion of capacity in the last decade. In 1976, modern plants produced an estimated 20 million tons, or 40 percent of national output. Actually, production has leveled off in the 1970s even though enough plants were built almost to double modern-plant capacity. The modern-plant sector's major problem is not inadequate capacity but inefficient use of existing capacity.

General Technological Upgrading

The Chinese have apparently begun a long-term program to upgrade the technological level of the cement industry. Some production increases have come from better and more powerful motors and other equipment at modern plants. The Chinese will undoubtedly soon begin installing preheaters (fuel-saving devices) both at older and at new, modern cement plants. Moreover,

they have reportedly converted some small plants from vertical kiln plants to modern rotary kilns. This part of the overall program will help to diffuse modern cement-making technology throughout the rural areas and thereby raise the technical skills of the small-plant workforce.

Changing Regional Distribution

In the mid-1960s the concentration of the cement industry began shifting away from the heavily industrialized northeast and coastal provinces to the interior and southwestern regions of the country. The share of national capacity of modern plants in the northern and eastern areas reportedly declined from an estimated 56 percent in 1966 to about 50 percent in 1975. In physical terms, the largest increase of modern plant capacity was in Szechwan Province, "China's breadbasket." Similarly, 50 percent of all small plants were in the northeast in 1972, but by 1976 this proportion had fallen to about 40 percent.

Cement Exports

The People's Republic of China (PRC) is not a major cement exporter but almost exercises a monopoly in the Hong Kong market, primarily to earn hard currency. China also exports some cement to Africa, Bangladesh, and Vietnam, much of it to support Chinese aid projects.

China's Cement Industry

Structure of the Industry

China's cement industry comprises a modern sector consisting of a type of rotary kiln plant common throughout the world and a small-plant sector of vertical shaft kilns. Vertical shaft kilns are essentially large stationary chimneys. They were used universally during the early development of the world's cement industry, but few such kilns are still in use outside China.¹

Small Plants

In 1976, China had 3,000 vertical kiln plants. These plants are clearly economically justified in a large, underdeveloped country like China. They require little capital investment, and because of their low level of technology, they can be financed and built locally without extensive help from Peking. Thus, they are an excellent way to introduce industry and technology into what is primarily an agrarian-peasant economy. (Many small plants are operated only seasonally.) They can be erected and be in operation within a year, whereas rotary kiln plants often take two or more years to complete. Also, vertical kiln plants can be operated and maintained more easily than large rotary kiln plants.

Small plants offer other economic advantages besides quick construction and easy operation. They use resources for which there is little demand and serve markets not important enough or large enough for centralized production and distribution plans. They are generally located in areas with an existing infrastructure of housing,

roads, and vacant land, thereby avoiding urban congestion and costs. In many cases, vertical plants put idle or castoff equipment and machinery back into productive use.

Cement from some of the larger vertical kiln plants is comparable in quality to that produced by modern plants; it can be substituted for cement from modern plants, thus saving considerable costs and easing distribution problems. But most of the cement produced by small plants is poor in quality and suitable only for low-strength agricultural and rural construction projects such as irrigation canals, culverts, houses, farm structures, and concrete poles. Small plants thereby contribute greatly to water conservation and rural construction efforts.

Modern Plants

The modern-plant sector comprises 90 plants with more than 180 rotary kilns. This is an increase of some 20 plants since 1970. Roughly half the modern plants use the slightly more fuel-efficient dry process; the remainder use the wet process. Slightly more than half the modern plants have more than one kiln. Most modern plants have a capacity of between 200,000 and 300,000 tons per year, compared with only 10,000 tons for small plants.

Trends in Cement Production

China produced an estimated 49 million tons of cement last year and is now the fourth largest producer in the world, after the Soviet Union, Japan, and the United States.²

In terms of physical output, the cement industry has performed well since 1949. Production has grown at an average annual rate of 17.3 percent since 1949 and has averaged a 10.8-

¹ The rotary kiln has several important advantages over the vertical kiln in making cement. As the name implies, a rotary kiln is a piece of cylindrical machinery that rotates continuously to produce cement clinker. The vertical kiln of the kind used in China is not a continuous process and must be reloaded and recharged after each batch of raw materials is fired—a time-consuming process. Moreover, it is much more difficult to control the quality of the cement produced in vertical kilns than in rotary kilns.

² The USSR is the largest with 124 million tons in 1976, followed by Japan with 69 million and the United States with 67 million.

Table 1

Cement Production ¹

	Output (Million Metric Tons)			Output From Small Plants as a Percent of Total	Exports (Million Metric Tons)
	Total	Modern Plants	Small Plants		
1949	0.66	0.66			
1950	1.41	1.41			
1951	2.49	2.49			
1952	2.86	2.86			
1953	3.88	3.88			0.3
1954	4.60	4.60			0.3
1955	4.50	4.50			0.4
1956	6.39	6.39			0.8
1957	6.86	6.86			1.3
1958	10.7	9.3	1.4	13	0.9
1959	12.3	10.6	1.7	14	0.8
1960	12.0	9.0	3.0	(25)	0.8
1961	7.8	6.0	1.8	(23)	1.0
1962	6.9	5.3	1.6	(23)	1.1
1963	9.1	6.8	2.3	(25)	0.9
1964	10.9	8.7	2.2	20	0.7
1965	16.3	10.9	5.4	33	1.0
1966	17.9	12.5	5.4	(30)	1.0
1967	14.2	10.6	3.6	(25)	0.5
1968	19.6	13.7	5.9	(30)	0.3
1969	22.5	14.4	8.1	(36)	0.3
1970	26.5	15.1	11.4	(43)	0.3
1971	30.9	18.5	12.4	40	0.6
1972	38.0	19.8	18.2	48	0.7
1973	40.8	20.4	20.4	50	1.0
1974	37.3	16.1	21.2	(57)	1.0
1975	46.9	19.3	27.6	59	1.3
1976	49.1	19.6	29.5	60	1.5

¹ Figures in parentheses are estimated on the basis of fragmentary data. Other figures are reported or derived from reported data. The source notes for this table follow on the next page.

percent growth since 1970. Sustained production increases have been broken only three times: in 1960-64 in the wake of the Leap Forward, in 1967 during the Cultural Revolution, and in 1974 following the severe shortfall in coal production and subsequent transportation problems.

The Small-Plant Sector

The high rate of growth in the cement industry in recent years has come largely from the rapid expansion of the small-plant sector. (See tables 2

and 3.) In 1964, for example, small plants accounted for only 20 percent of national output. By 1971, their share had doubled and, by 1976, had jumped to 60 percent of total production. Small-plant expansion has resulted in an impressive 18.6-percent average annual rate of increase in small-plant production during the last decade, treble the rate set by modern plants.

The surge in output over the last decade reflects the relative ease of expanding the small-plant sector compared with the difficulties of

Sources for Table 1

- 1949-57: State Statistical Bureau, *Ten Great Years*, Peking 1960, p. 96.
- 1958: Modern-plant output reported in *Ten Great Years*. Small-plant output reported in *Chien-chu ts'at-liao kung-yeh*, No. 6, 22 Mar 1959, pp. 6-9.
- 1959: Total and small-plant output reported in *Survey of Chinese Mainland Publications*, No. 2191, 1 Feb 1960, p. 8.
- 1960: Modern- and small-plant outputs are estimated. The latter figure is based on a New China News Agency (NCNA) press release, 26 Apr 1960, that reported small plants to have an aggregate capacity of 3.6 million tons. The 33-percent share for small plants reported in *FBIS*, 22 Nov 1960, p. B-7, is no longer accepted.
- 1961: Modern- and small-plant outputs are estimated.
- 1962: Total output is derived from the 1963 increase of 32 percent reported in *Chien-chu ts'at-liao kung-yeh*, No. 5, 1964, p. 2. The share of small plants is estimated.
- 1963: Total production is derived from the 1964 increase of 20 percent reported in *FBIS*, 31 Dec 1964, p. C-2. The small-plant share is estimated.
- 1964: Modern-plant output is derived from the 1965 increase of 25 percent reported in NCNA, 23 Dec 1965. The small-plant share is given in an NCNA release of 6 Feb 1965. Total production is consistent with a statement reported in *Chung-kuo hsin-wen*, 22 Feb 1965, p. 4, that output in 1964 was 16 times output in 1949.
- 1965: Small-plant output is derived from the statement reported in *FBIS*, 8 Dec 1976, p. E-14, that output in 1975 was 5.1 times output in 1965 with a 17.8-percent average annual rate of growth. This rate yields a multiple of 5.146. The small-plant share is derived from the statement in NCNA, 23 Dec 1965, that the share was 65 percent higher than the share in 1964.
- 1966: Modern-plant output is estimated to rise 15 percent based on fragmentary data on increases in capacity. The small-plant share of output is estimated to fall to 30 percent.
- 1967: Total output is estimated from fragmentary data. Small-plant share is estimated to fall to 25 percent.
- 1968: Total output is estimated from fragmentary data. Small-plant share is estimated.
- 1969: Small-plant output is derived from the statement in *Summary of World Broadcasts*, Far East, W 707/A-13, 17 Jan 1973, that output increased by an average annual rate of growth of 31 percent between 1969 and 1972. Small-plant share is estimated.
- 1970: Small-plant output is derived from the statement in *Peking Review*, No. 2, 11 Jan 1974, p. 23, that output from 1970 to 1973 achieved an annual average increase of over 3 million tons. The small-plant share was stated to be more than 40 percent of total output in *FBIS*, 6 Dec 1971, p. B-2.
- 1971: Total output is derived from the 1971 increase of 16.5 percent reported in *FBIS*, 3 Jan 1972, pp. B 10-12. The small-plant share is given in the same source.
- 1972: Total output is derived from the 1972 increase of 23 percent reported in *China Trade Report*, Vol. X, No. 12, Hong Kong, p. 11. Small-plant output is derived from the statement in *Peking Review*, No. 2, *op. cit.*, that output in 1972 was 3.4 times output in 1965. The small-plant share is given in *FBIS*, 3 Jan 1973, p. B-2.
- 1973: Small-plant output is derived from the 12-percent increase for 1973 reported by NCNA, 22 Dec 1973. The small-plant share is given in *Peking Review*, No. 46, 15 Nov 1974, p. 23.
- 1974: Total output is derived from the statement reported in *China's Foreign Trade*, No. 1, Peking, 1976, p. 5, that output rose more than 50 times 1949's output, with an average annual rate of growth of 18 percent. Since a rate of 18 percent implies a multiple of 62.7, we accept a 17.5-percent annual rate and a multiple of 56.4. Small-plant output is derived from output in 1975 and the increase of 30 percent over 1974 reported in a *Summary of World Broadcasts*, Far East, W 854/A-17, 26 Nov 1975. The small-plant share is consistent with the statement in *FBIS*, 21 Jan 1975, p. E-5, that the share was more than 50 percent.
- 1975: Total output is derived from the statement reported in *Ching-chi Tao-pao*, No. 37, Hong Kong, 22 Sep 1976, pp. 14-16, that output in 1975 increased over 70 times output in 1949. The small-plant share is given in *FBIS*, 19 Nov 1976, p. E-2, as 58.8 percent.
- 1976: Small-plant output is derived from the 1976 increase of 6.8 percent reported in *Summary of World Broadcasts*, Far East, W 910/A-11, 5 Jan 1977. Small-plant share is given in *Ching-chi Tao-pao*, No. 50, Hong Kong, 22 Dec 1976, p. 11, and *China Reconstructs*, Peking, Jul 1977.

building modern plants. The expansion program originated during the Leap Forward of the late 1950s, fell into disuse in the early 1960s, and resumed during the Cultural Revolution. The Cultural Revolution set higher priorities for small industrial plants in general and for the small cement plants in particular.

The Modern-Plant Sector

Modern-plant production has fallen well behind the small-plant sector despite considerable

expansion of capacity in the last decade. In 1976, modern plants produced an estimated 20 million tons, or 40 percent of national output, down from 60 percent in 1971. Output grew at a moderate 6.7-percent average annual rate in the Third Five-Year Plan (1966-70), but declined sharply to only 4.4 percent during 1971-76. Lagging modern-plant output directly affects several important sectors of the economy because modern plants supply almost all the better quality cement used in high-priority military projects, heavy industry, and urban housing.

Some production increases resulted from expansion efforts over the last decade. Peking began a large-scale construction program in the mid-1960s utilizing only domestically designed machinery. Fragmentary data indicate that between 1965 and 1976, the Chinese added almost as much capacity as was in existence in 1965. Although most of this additional capacity was probably completed in the 1970s, increments are reportedly now coming at a snail's pace.

The fall-off in adding capacity may be attributed in part to a shift from erecting very large rotary kilns, as was done in the early part of the expansion program, to much smaller kilns. Contrary to world practices, which favor kilns with capacities of more than 500,000 tons, the Chinese build kilns that average considerably less. The Chinese have reportedly adopted standard-sized rotary kilns of 30,000- to 200,000-ton capacity; the most prevalent new kilns are of the relatively small 60,000-ton capacity.

A nagging problem of the modern sector is inefficient use of existing capacity. Estimated utilization rates have been in sharp decline since 1973 and now probably average around 75 percent, well below world standards of efficiency. This average, however, covers the period of the Gang of Four problems and critical fuel and transportation difficulties, so a sharp decline is not unexpected. The rate for 1967-76 is much

better—probably around 85 percent—but still below world standards. (This period was severely affected by the turmoil of the Cultural Revolution.) Low utilization rates will continue to hamper the industry in the near future, partly because Chinese plants depend on the overworked coal industry.

Table 3

Distribution of Small Cement Plants

	1972	1976
Total¹	2,400	3,000
Provincial totals¹	2,295	2,897
Northeast	266	266
Heilungkiang	47	47
Kirin	117	117
Liaoning	102	102
North	604	610
Hopeh	129	129
Inner Mongolia	40	40
Shansi	225	225
Shantung	210	216
East	436	436
Anhui	77	77
Chekiang	80	80
Fukien	59	59
Kiangsi	127	127
Kiangsu	93	93
Central and South	373	645
Honan	100	140
Hunan	2 ²	196
Hupei	9 ²	9 ²
Kwangsi	112	110
Kwangtung	150	190
Southwest	170	432
Kweichow	NA ³	25
Szechwan	84	320
Tibet	2	3
Yunnan	84	84
Northwest	446	508
Kansu	77	80
Ninghsia	24	24
Shensi	307	307
Sinkiang	37	80
Tsinghai	1	17

¹ Total represents the number of small cement plants nationwide that was reported in the Chinese press. Provincial statistics were derived from provincial press reports.

² Minimum number. No provincial total was reported.

³ Not available.

Table 2

Growth of Small Cement Plants

	Output of Small Plants		Number of Plants ¹	Average Output (Metric Tons)
	Million Metric Tons	Percent of Total		
1971	12.4	40	1,800	6,900
1972	18.2	48	2,400	7,600
1973	20.4	50	2,800	7,300
1974	21.2	57	2,800	7,600
1975	27.6	59	3,000	9,200
1976	29.5	60	3,000	9,900

¹ Derived from Chinese press reports. For distribution of small plants, by region, see table 3.

Changing Geographical Distribution

The concentration of the cement industry in China is gradually spreading south and west from the heavily industrialized north and east. The bulk of the modern plants have traditionally been located in the northern and eastern regions, but this concentration is shifting to the south. Fragmentary data indicate that the north and east accounted for an estimated 56 percent of national capacity in 1966 and just over 50 percent in 1975. At the same time, the proportion of national capacity located in the south and southwest jumped from an estimated 35 percent in 1966 to about 42 percent in 1975. Szechwan Province in southwest China currently has the largest cement capacity of any province in China, a distinction formerly held by Liaoning Province in the northeast.

Technological Improvements

The Chinese are engaged in a long-term program to upgrade the technological level of both the modern- and small-plant sectors of the cement industry. In the modern sector, some in-

creased production has come from installing better crushing equipment, more powerful motors, and conveyors to move raw materials. These improvements will not significantly raise production unless they are also combined with more basic improvements such as preheaters. These units are commonly used in the West to save fuel by recycling waste gases to start the heating of raw materials before they reach the kiln. Preheater technology is widely available, and the Chinese could install it at older large rotary kiln cement plants as well as at the new ones.

Instead of continuing the program to build hundreds of additional small plants, the Chinese apparently are attempting to upgrade the technical level of those already in place. They have reportedly begun to replace vertical kilns with small rotary kilns, thus increasing the output of higher quality cement while using the same amount of raw materials. This approach will gradually diffuse modern cement-making technology throughout the rural areas and improve the technical skills of the small-plant workforce. The conversion of vertical kilns to rotary kilns is clearly dependent on an adequate supply of machinery, and its availability is not known because of probable damage to a cement machinery plant in a section of Tangshan hit hard by the July 1976 earthquake.

Cement Exports

China's primary foreign market for cement is Hong Kong, which imports 460,000 tons annually. The dominant position of the PRC in the

Table 4

Utilization of Modern Cement Plant Capacity

	Output (Million Metric Tons)	Estimated Capacity ¹ (Million Metric Tons)	Estimated Utilization (Percent)
1965	11	13	85
1966	12	14	86
1967	11	15	73
1968	14	15	93
1969	14	15	93
1970	15	18	83
1971	18	19	95
1972	20	21	95
1973	20	22	91
1974	16	24	67
1975	19	25	76
1976	20	26	77

¹ Based on fragmentary data. Production and capacity totals are estimated by different methods. Rates of utilization should be considered only as approximations, but the trends are correct.

Table 5

Distribution of Cement Production Capacity
Percent

	1966	1970	1975
Total	100	100	100
Northeast	22	17	17
North	14	16	13
East	20	18	21
Central and South	16	15	20
Southwest	19	27	22
Northwest	9	7	7

Table 6
Cement Exports to and Prices
in Hong Kong

	Thousand Metric Tons	US \$ per Metric Ton
1970	211	15
1971	365	16
1972	488	18
1973	639	26
1974	444	57
1975	469	40
1976	457	39

Hong Kong market gives the Chinese nearly monopolistic power in setting prices for cement. In 1974, for example, the PRC more than doubled the average price from \$26 per ton to \$57 per ton (up to \$68 retail) in an attempt to earn more hard currency. The price dropped back to \$40 in 1975 and 1976 but is still significantly above the world price of about \$25 f.o.b.

In addition to Hong Kong, China exports some cement to Africa, Bangladesh, and Vietnam. Much of this cement is given as aid to support construction of Chinese aid projects such as the Tan-Zam railroad.

Cement Prices

Cement prices at the factory have not changed significantly since 1957. The construction of more cement plants in a better geographical

distribution, however, has undoubtedly lowered transport charges and reduced the cost of delivered cement to consumers.

Table 7
Cement Prices
Yuan per Metric Ton

	Total	Factory Price ¹	Transport Charges ²
1952	122	62	60
1957	115	55	60
1965	105	55	50
1970	99	54	45
1975	93	53	40

¹ Grade 400 cement is assumed to be the average grade, and its price is taken for all cement.

² This is a representative transport charge compiled from numerous sources.

Sources for Table 7

1952: *Chieh-fang ch'ien-hou wu-chieh tsu-liao hui-pien, 1921-1957* (Shanghai Price Book, 1921-1957), Shanghai, 1958, pp. 510-511. The price for 1952 is derived from the 1957 price and index.

1957: *Ibid.*

1965: Calculated from three prices for Grade 400 cement produced in several locations.

1970: *Design and Construction of Floors of Small and Medium Scale Machinery Factory Buildings*, Tientsin, 1972, p. 22.

1975: Interviews with legal immigrants to Hong Kong in 1974-76. Prices range from 44 yuan, paid by the Peking Municipal Construction Bureau to the Peking Cement Plant in 1975, to 58 yuan for Grade 400 cement sold in Heilungkiang Province in 1976. In 1974 a coal mining machine factory paid 56 yuan per ton.

